AP® CHEMISTRY
2007 SCORING GUIDELINES (Form B)

Question 6

	First Ionization Energy (kJ mol^{-1})	Second Ionization Energy (kJ mol^{-1})	Third Ionization Energy (kJ mol^{-1})
Element 1	1,251	2,300	3,820
Element 2	496	4,560	6,910
Element 3	738	1,450	7,730
Element 4	1,000	2,250	3,360

The table above shows the first three ionization energies for atoms of four elements from the third period of the periodic table. The elements are numbered randomly. Use the information in the table to answer the following questions.

(a) Which element is most metallic in character? Explain your reasoning.

Element 2. It has the lowest first-ionization energy. Metallic elements lose electron(s) when they become ions, and element 2 requires the least amount of energy to remove an electron.	One point is earned for the identification. One point is earned for the justification.

(b) Identify element 3. Explain your reasoning.

Magnesium. Element 3 has low first and second ionization energies relative to the third ionization energy, indicating that the element has two valence electrons, which is true for magnesium. (The third ionization of element 3 is dramatically higher, indicating the removal of an electron from a noble gas core.)	One point is earned for the identification. One point is earned for the justification.

(c) Write the complete electron configuration for an atom of element 3.

$1s^2\ 2s^2\ 2p^6\ 3s^2$	One point is earned for the correct electron configuration.

(d) What is the expected oxidation state for the most common ion of element 2?

1+	One point is earned for the correct oxidation state.

Question 6 (continued)

(e) What is the chemical symbol for element 2?

Na	One point is earned for the correct symbol.

(f) A neutral atom of which of the four elements has the smallest radius?

Element 1	One point is earned for the correct identification of the element.

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(a) Which element is most metallic in character? Explain your reasoning.

(b) Identify element 3. Explain your reasoning.

(c) Write the complete electron configuration for an atom of element 3.

(d) What is the expected oxidation state for the most common ion of element 2 ?

(e) What is the chemical symbol for element 2 ?

(f) A neutral atom of which of the four elements has the smallest radius?

(a) The characteristic of metal is its tendency to lose electrons easily. To do so, the first Ionization energy should be small. Therefore, Element 2, which has the smallest first ionization energy is most metallic.

(b) We can figure out the third ionization energy is much larger than the second one. This means, the third ionization occured in the inner obrbitals compared to first or second ionization. Therefore, there should be two valence electrons in s orbital. In third period, Mg successfully satisfies this condition

(c) $1s_2\ 2s_2 2p_6\ 3s_2$

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ADDITIONAL PAGE FOR ANSWERING QUESTION 6.

(d) We can find out that the first ionization energy of element 2 is relatively much smaller than the second ionization energy of it.
Therefore, losing only one electron would be plausible within this element.
Therefore, (Element 2) → (Element)$^{1+}$ + e^{1-}

∴ oxidation state: 1+

(e) Third period atom with one valence electron in its s-orbital is Na in 1A group. Alkali metal

(f) Smallest radius means the atom is closely packed and it is difficult to lose electron.
Therefore, the element with the highest first Ionization energy is Element 1!

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(b) Identify element 3. Explain your reasoning.

(c) Write the complete electron configuration for an atom of element 3.

(d) What is the expected oxidation state for the most common ion of element 2 ?

(e) What is the chemical symbol for element 2 ?

(f) A neutral atom of which of the four elements has the smallest radius?

a) element 2 : because it has least 1st ionization energy, which means it tends to lose electron easily, which is a property of metals.

b) Ba, because it tends to lose 2 e⁻ electrons easily, after that, the ionization energy for the third electron is much higher than the first 2. so the element must have +2 oxidation state.

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ADDITIONAL PAGE FOR ANSWERING QUESTION 6.

c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2$

d) +1, because it 1st ionization energy is low comparing to the next 2, which means it loses its first electron easily.

e) Li

f) element 4, because even it first ionization energy is high, which indicates the strong attraction between protons and electrons.

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(c) Write the complete electron configuration for an atom of element 3.

(d) What is the expected oxidation state for the most common ion of element 2 ?

(e) What is the chemical symbol for element 2 ?

(f) A neutral atom of which of the four elements has the smallest radius?

6a) Element 1, reason is because ionization energy increase to the right of a period.

b) Mg, because at the I_2 to I_3 there is a huge jump meaning that it would take a huge amount of energy to remove an electron from the 3rd period to become the 2nd period.

c) $1s^2\ 1p^6\ 2s^2\ 2p^6\ 3s^2$

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B B B B B B B B

6 C_2

ADDITIONAL PAGE FOR ANSWJ

d) Mg^+; Oxidation state is +1

e) Na

f) Element 2, because Ionization energy increase to the right of a period

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AP® CHEMISTRY
2007 SCORING COMMENTARY (Form B)

Question 6

Sample: 6A
Score: 8

This response earned all 8 points: 2 for part (a), 2 for part (b), 1 for part (c), 1 for part (d), 1 for part (e), and 1 for part (f).

Sample: 6B
Score: 5

Both points were earned in part (a). Only 1 point was earned in part (b); although barium is in the wrong period and did not earn a point, the same reasoning is correct for magnesium, a member of the same group. The point was earned in part (c) because the correct electron configuration for the element selected in part (b) is given. The point was earned in part (d). The point was not earned in part (e) because lithium is not a period three element. The point was not earned in part (f).

Sample: 6C
Score: 4

The points were not earned in part (a). Both points were earned in part (b). The point was not earned in part (c). The point was earned in part (d) because although the wrong symbol is given, the oxidation state is correct. The point was earned in part (e). The point was not earned in part (f).